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EVIDENCE AGAINST AN I=5/2 BARYON RESONANCE OF MASS 1640 MeV/c

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### Authors

Danburg, Jerome S.
Davies, Donald W.
Dahl, Orin I.
et al.

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UCRL-18898

# EVIDENCE AGAINST AN I=5/2 BARYON RESONANCE OF MASS 1640 MeV/$c^2$

Jerome S. Danburg, Donald W. Davies, Orin I. Dahl, Paul L. Hoch, Janos Kirz*, Donald H. Miller, and Robert K. Rader
Lawrence Radiation Laboratory, University of California, Berkeley, California 94720
and
Maris A. Abolins, Thalis Delikaris, and Gerald A. Smith
Michigan State University, East Lansing, Michigan 48823

* Now at State University of New York, Stony Brook (L.I.), New York 11790

Abstract: Recently evidence has been presented for the production of an I=5/2 nonstrange baryon resonance of mass ≅ 1640 MeV/$c^2$, in the reaction $\pi^- d \to (p)\, n \pi^- \pi^- \pi^+$. With much greater statistics, our data for the charge-symmetric reaction fails to show any evidence for such a resonance.

Benvenuti et al.[1] have reported confirmation of an I = 5/2 baryon resonance of mass 1640 MeV/$c^2$ previously seen by Banner et al.[2] It is the purpose of this paper to present equivalent data with greatly improved statistics, showing no enhancement in this mass region.

Benvenuti et al. present data on the reaction

$$\pi^- d \longrightarrow (p)\, n\, \pi^-\, \pi^-\, \pi^+ \qquad (1)$$

at an incident pion momentum of 2.26 BeV/c. Here (p) indicates that the final state proton does not take part in the reaction. 2447 3-pronged events (with protons of momentum too low to produce a visible track in the bubble chamber) were analyzed in their paper. They report a narrow ($\Gamma \leq 60$ MeV/$c^2$) peak in the $n\pi^-\pi^-$ mass spectrum, which is enhanced to 4 standard deviations when the momentum transfer from the beam to the $\pi^+$ is restricted to be less than 0.6 (BeV/$c$)$^2$. They also make cuts which indicate that the peak may decay via a $\Delta^-(1236)\pi^-$ mode.

We have analyzed ≈16000 4-pronged events from the reaction

$$\pi^+ d \longrightarrow (n)\, p\, \pi^+\, \pi^-\, \pi^- \qquad (2)$$

at incident momenta between 1.1 and 2.37 BeV/c. By charge symmetry this reaction is identical in its description to reaction (1); however, these events admit a better mass resolution than the 3-pronged events of reference 1. The events analyzed have been selected to have neutron laboratory momentum less than 300 MeV/c, to insure that the neutron is a "spectator" to the collision. We have also excluded events with confidence level for reaction (2) less than 1 %. We estimate that the contamination from other final states is less than 5%.

Our data has been divided into two intervals in beam momentum; the exposure size for each interval is about 7 events/μb. Interval I contains momentum settings at 1.10, 1.30, 1.52, 1.58, and 1.70 BeV/c; interval II contains momentum settings at 1.86, 2.15, and 2.37 BeV/c. The latter interval spans the momentum settings of references 1 and 2.

Figure 1 shows the $p\,\pi^+\,\pi^+$ mass spectrum; the shaded events are those for which the beam-to-$\pi^-$ momentum transfer is less than 0.6 $(\mathrm{BeV}/c^2)^2$. We note that this figure is equivalent to figure 1a) of reference 1. We see no enhancement at or near 1640 $\mathrm{MeV}/c^2$, either in the raw data or after the momentum transfer cut. For completeness, Figures 2 and 3 show data corresponding to figures 1b) and 2 of reference 1. Selecting $\Delta^{++}\pi^+$ events (Figure 2) does not produce an enhancement, nor does excluding $\Delta^{++}p^o$ events (Figure 3).

We note that the momentum transfer cut made by Benvenuti *et al.* and reproduced in our Figure 1 would enhance the production of an assumed $I = 5/2$ baryon resonance if it were produced via the exchange of a meson. However, in this case the meson would have to be doubly charged. A more likely exchange mechanism for production of an $I = 5/2$ baryon in these reactions would be $I = 3/2$ baryon exchange. We have also made cuts

corresponding to production by baryon exchange, and we see no enhancement. Finally we note that we have examined the $p\,\pi^+\,\pi^+$ mass spectrum at each of our momentum settings separately, and we find no evidence for an enhancement at any of them.

In conclusion, we see no evidence for a narrow ( $\Gamma \leq 60$ MeV/$c^2$) resonance in the mass range 1500 - 2000 MeV/$c^2$. The 40 μb production cross section reported by Benvenuti et al. would correspond to a 6 standard deviation enhancement in either of our beam momentum intervals.

REFERENCES:

1) A. Benvenuti, E. Marquit, and F. Oppenheimer, Phys. Rev. Letters 22, 970 (1969).

2) M. Banner et al., cited in Proceedings of the International Conference on Elementary Particles, Heidelberg, Germany, 1967, edited by H. Filthuth (North-Holland Publishing Company, Amsterdam, The Netherlands, 1968), p. 112.

FIGURE LEGENDS:

Fig. 1. $p\pi^+\pi^+$ mass spectrum; shaded events are those with beam-to-$\pi^-$ momentum transfer $|t|$ less than 0.6 $(\text{BeV}/c^2)^2$. (a): 7081 events in beam momentum interval I; (b): 9056 events in interval II.

Fig. 2. $\Delta^{++}(1236)\pi^+$ mass spectrum for $|t|$ (beam to $\pi^-$) less than 0.6 $(\text{BeV}/c^2)^2$. $\Delta^{++}$ is defined as $1120\ \text{MeV}/c^2 < M(p\pi^+) < 1320\ \text{MeV}/c^2$. (a): events in beam momentum interval I; (b): events in interval II.

Fig. 3. $p\pi^+\pi^+$ mass spectrum for $|t|$ (beam to $\pi^-$) less than 0.6 $(\text{BeV}/c^2)^2$ and $\Delta^{++}\rho^o$ events excluded. $\Delta^{++}$ is defined as in Figure 2; $\rho^o$ is defined as $710\ \text{MeV}/c^2 < M(\pi^+\pi^-) < 810\ \text{MeV}/c^2$. (a): events in beam momentum interval I; (b): events in interval II.

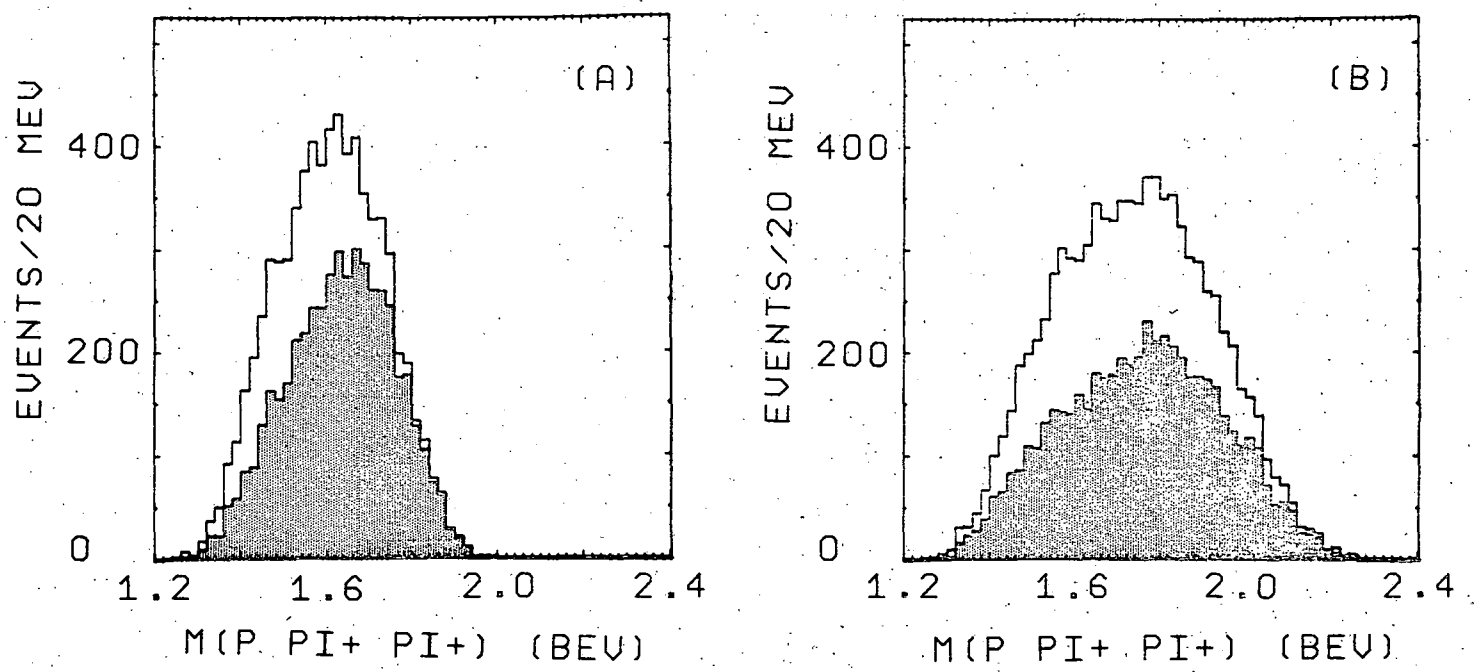


FIGURE 1

XBL 695-506

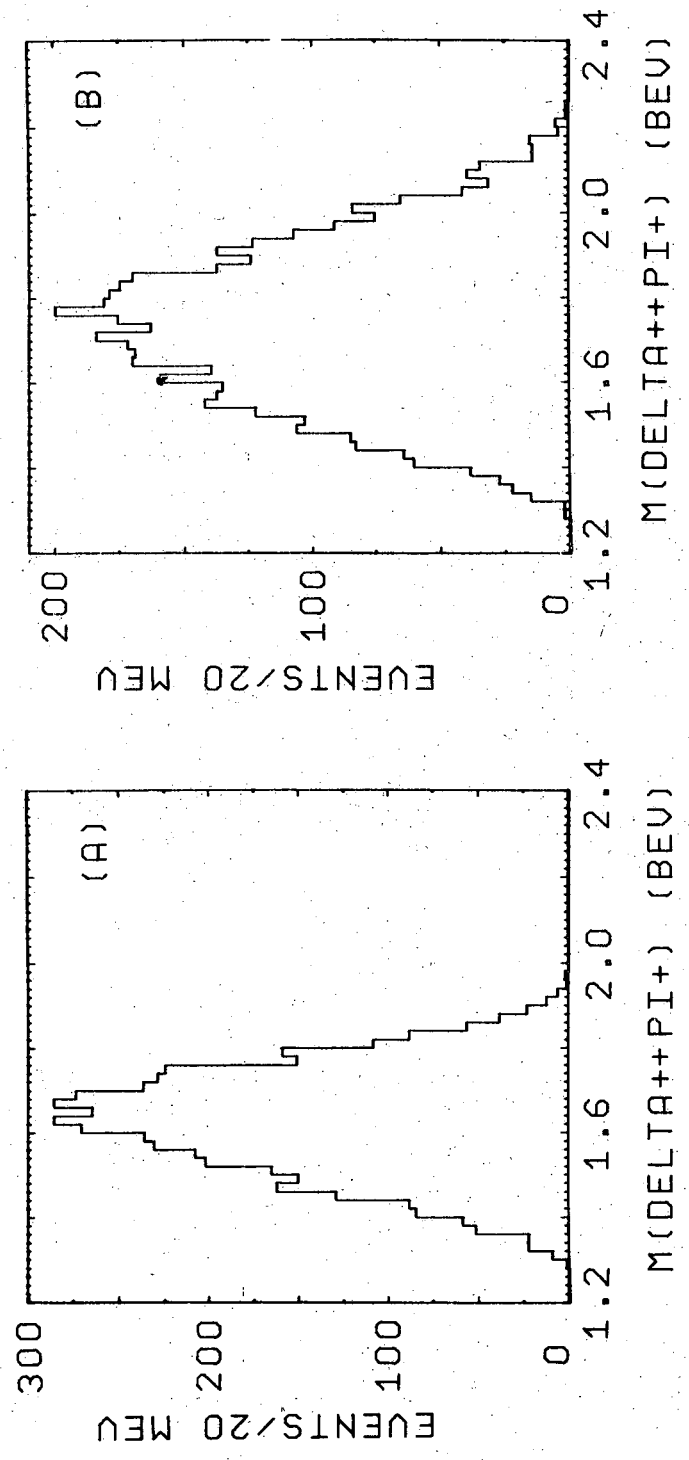


FIGURE 2

XBL 695-507

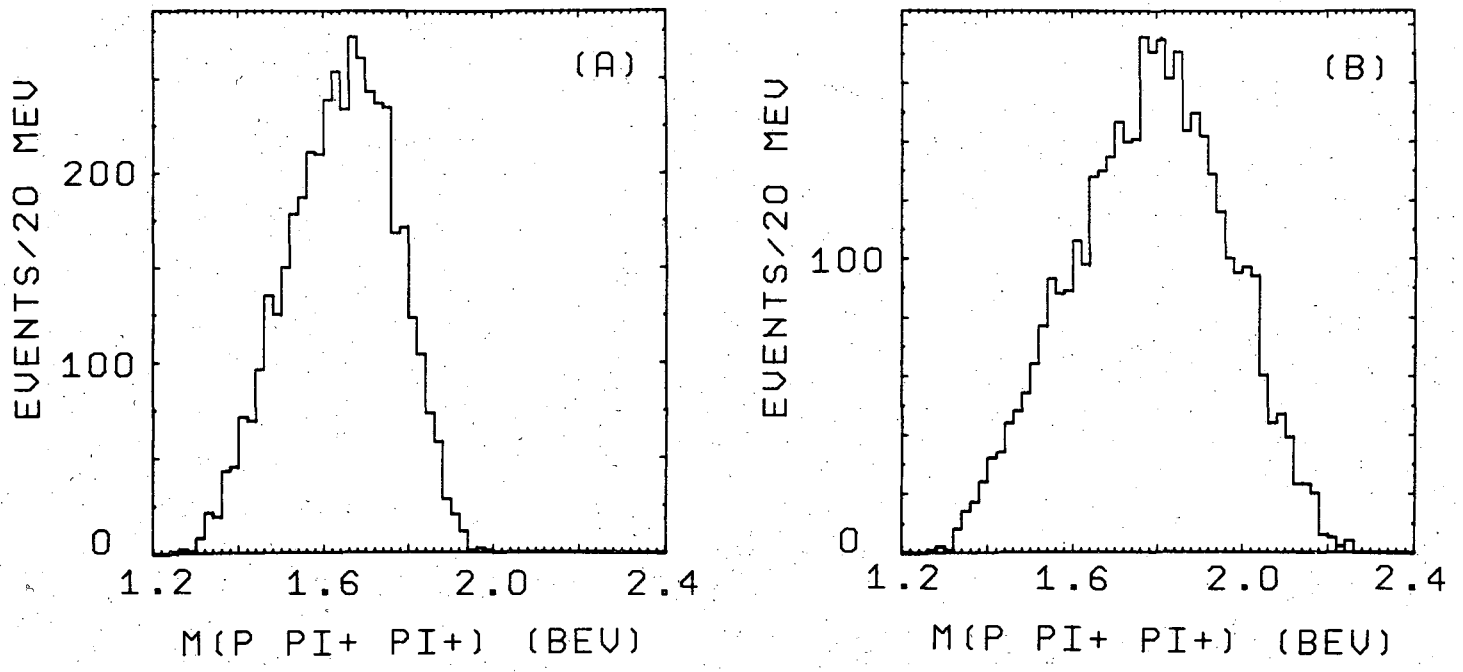


FIGURE 3

XBL 695-508

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